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# COMPOSITION OF SUGAR-BEET PULP AND TOPS AND OF SILAGE THEREFROM

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## INTRODUCTION

The great value of beet tops and pulp and silage therefrom as a feeding material for cattle, sheep, etc., has been demonstrated by the results of a large number of comparative feeding experiments carried on by State agricultural experiment stations, beet-sugar companies, and others, but data relative to the actual feeding composition of this material are rather meager. The available data ordinarily give the composition of single samples or the average composition, and it is difficult to find published data showing the range of variation of constituents such as protein, fat, and fiber. A notable exception is the circular published by Neidig,[1] giving the composition of 10 samples of silage from beet tops, which show a wide variation in the composition of individual samples. Most of these samples contained an excessive quantity of dirt, which upon the basis of the water-free material averaged 32.03 per cent for the 10 samples and in 2 samples ranged as high as 48.19 and 53.44 per cent. The crude ash (ash plus dirt) averaged 45.18 per cent, and in the 2 samples referred to ranged as high as 63.59 and 64.82 per cent.

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[1] Neidig, R. E. Sugar beet top silage. Idaho Agr. Exp. Sta. Circ. 17, 4 p. 1921.

## PURPOSE AND METHOD OF STUDY

The data given herein are the result of an investigation carried on for the purpose of obtaining information relative to the range of variation in the constituents ordinarily considered in valuing cattle-feed materials. The samples were collected a few at a time during the seasons of 1918–19, 1919–20, 1920–21, and 1922–23, from various points in the States mentioned in Tables 1, 3, and 5. The samples of pulp were representative of that freshly dumped from the extraction battery and the samples of tops representative of those removed from the beets at harvest. The samples of silage were from ordinary pit silos. In order that the samples might be representative of what is ordinarily used for feeding purposes, no attempt was made to remove adhering dirt. The weight of the wet sample was obtained and the entire sample dried, placed in an ordinary paper sack, and shipped to Washington for analysis. Analyses of this dry material were made and the results calculated to original and to water-free bases. The methods used were those published by the Association of Official Agricultural Chemists.[2]

## DISCUSSION OF RESULTS

Although it is not the purpose of this circular to consider the feeding value of beet pulp and tops, it may be pointed out that they do not constitute a complete feed but must be fed in conjunction with hay, grain, etc. A discussion of the feeding value of these materials, together with typical rations, may be found in Farmers' Bulletin 1095,[3] a copy of which may be obtained free by sending a request to the Department of Agriculture, at Washington, D. C.

Table 1 gives the results of the analyses of beet pulp.

The variations in the constituents of the pulp are probably due to natural variations in the growth of the plant and the effect of the process of extraction, although in some cases they may be influenced by the presence of excessive crude ash resulting from the imperfect washing of the beets at the factory. The extremes of variation are shown in Table 2.

Table 3, giving the results of analyses of beet-pulp silage, shows a marked decrease in the percentage of nitrogen-free extract as compared with that in fresh pulp.

The extremes of variation in the constituents are shown in Table 4.

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[2] Association of Official Agricultural Chemists. Official and tentative methods of analysis, as compiled by the committee on revision of methods. Revised to November 1, 1919. 417 p., 18 fig. Washington, D. C. 1920. (Bibliographies at ends of chapters.)

[3] Jones, James W. Beet-top silage and other by-products of the sugar beet. U. S. Dept. Agr., Farmers' Bul. 1095, 24 p., 12 fig. 1919.

TABLE 1.—*Composition of beet pulp*

[T=trace. The results in columns 22 to 29 under "Quoted analyses" were calculated from quoted figures on dried pulp]

| Source | Original wet pulp (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N× 6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Michigan | 84.08 | 15.92 | 0.53 | 1.56 | 0.04 | None. | 10.30 | 0.14 | 3.38 | 0.04 |
| | 83.34 | 16.66 | .56 | 1.42 | .03 | 0.02 | 11.15 | .04 | 3.49 | .05 |
| | 86.05 | 13.95 | .46 | 1.22 | .03 | .02 | 9.33 | .05 | 2.89 | .05 |
| | 84.25 | 15.75 | .59 | 1.47 | .04 | .07 | 10.35 | .10 | 3.24 | .11 |
| | 86.46 | 13.54 | .52 | 1.38 | .04 | .08 | 8.58 | .09 | 2.97 | .13 |
| | 86.18 | 13.82 | .52 | 1.43 | .03 | .04 | 8.76 | .09 | 3.02 | .07 |
| | 86.33 | 13.67 | .49 | 1.34 | T | .07 | 8.92 | .08 | 2.83 | .07 |
| | 81.84 | 18.16 | .67 | 1.72 | T | .09 | 11.88 | .09 | 3.80 | .09 |
| Average | 84.82 | 15.18 | .54 | 1.44 | .03 | .05 | 9.91 | .09 | 3.20 | .08 |
| Utah | 96.23 | 3.77 | .21 | .46 | .02 | .01 | 2.07 | .02 | 1.00 | .03 |
| | 93.30 | 6.70 | .41 | .73 | .02 | T | 3.78 | .06 | 1.71 | .02 |
| | 94.40 | 5.60 | .25 | .60 | .03 | .04 | 3.43 | .03 | 1.28 | .07 |
| | 92.69 | 7.31 | .32 | .69 | .02 | .05 | 4.61 | .04 | 1.65 | .07 |
| | 96.40 | 3.60 | .23 | .49 | .02 | .02 | 1.84 | .04 | 1.00 | .04 |
| Average | 94.60 | 5.40 | .28 | .59 | .02 | .02 | 3.15 | .04 | 1.33 | .04 |
| Colorado | 96.38 | 3.62 | .23 | .57 | .01 | T | 1.77 | .04 | 1.02 | .01 |
| | 95.59 | 4.41 | .29 | .53 | .01 | T | 2.49 | .03 | 1.08 | .01 |
| | 95.14 | 4.86 | .52 | .49 | .01 | .01 | 2.60 | .04 | 1.21 | .02 |
| Average | 95.70 | 4.30 | .35 | .53 | .01 | T | 2.29 | .04 | 1.10 | .01 |
| Kansas | 94.64 | 5.36 | .22 | .59 | .01 | .01 | 3.43 | .02 | 1.10 | .02 |
| | 94.20 | 5.80 | .22 | .64 | .02 | .02 | 3.72 | .02 | 1.19 | .04 |
| | 91.98 | 8.02 | .53 | .77 | .03 | .06 | 4.97 | .03 | 1.73 | .09 |
| | 90.88 | 9.12 | .39 | .84 | .01 | .12 | 5.89 | .02 | 1.98 | .13 |
| | 94.05 | 5.95 | .20 | .57 | .01 | .04 | 3.96 | .03 | 1.20 | .05 |
| | 94.26 | 5.74 | .22 | .56 | .02 | .03 | 3.79 | .02 | 1.15 | .05 |
| Average | 93.33 | 6.67 | .30 | .66 | .02 | .04 | 4.29 | .02 | 1.39 | .06 |
| California | 91.96 | 8.04 | .23 | .81 | .02 | .07 | 5.42 | .04 | 1.53 | .09 |
| | 92.15 | 7.85 | .25 | .85 | T | T | 5.01 | .03 | 1.71 | T |
| | 91.95 | 8.05 | .33 | .89 | .04 | .45 | 5.12 | .04 | 1.67 | .49 |
| Average | 92.02 | 7.98 | .27 | .85 | .02 | .17 | 5.18 | .04 | 1.64 | .19 |
| Average: 25 samples | 90.99 | 9.01 | .38 | .90 | .02 | [1].04 | 5.73 | .05 | 1.95 | [1].06 |
| Maximum | 96.40 | 18.16 | .67 | 1.72 | .04 | [1].12 | 11.88 | .14 | 3.80 | [1].13 |
| Minimum | 81.84 | 3.60 | .20 | .46 | T | None. | 1.77 | .02 | 1.00 | T |
| Spread | 14.56 | 14.56 | .47 | 1.26 | .04 | .12 | 10.11 | .12 | 2.80 | .13 |
| QUOTED ANALYSES | | | | | | | | | | |
| Shaw [2] | 90.00 | 10.00 | .36 | 1.15 | -------- | -------- | 6.25 | .13 | 2.11 | -------- |
| Brock [3] | 89.90 | 10.10 | .4 | 1.0 | -------- | -------- | 6.3 | .2 | 2.2 | -------- |
| Henry and Morrison [4] | 90.70 | 9.30 | .4 | .9 | -------- | -------- | 5.7 | .2 | 2.1 | -------- |

[1] Omitting 0.45 and 0.49 results; average of 24 samples.

[2] Shaw, G. W. Field talks with sugar-beet growers. In Beet Sugar Gaz., v. 5, p. 239. 1903.

[3] Brock, J. A. Feeding beet products. *In* Facts about Sugar, v. 9, p. 410, 411. 1919.

[4] Henry, W. A., and B. F. Morrison. Feeds and feeding. Ed. 18. x, 770 pp., illus. Madison, Wis. 1923.

TABLE 1.—*Composition of beet pulp*—Continued

| Source | Dried pulp (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N× 6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| 1 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Michigan | 6.89 | 93.11 | 3.10 | 9.13 | 0.25 | None. | 60.26 | 0.85 | 19.77 | 0.25 |
| | 5.24 | 94.76 | 3.18 | 8.06 | .17 | 0.11 | 63.42 | .26 | 19.84 | .28 |
| | 5.29 | 94.71 | 3.14 | 8.25 | .20 | .16 | 63.31 | .33 | 19.67 | .36 |
| | 8.35 | 91.65 | 3.42 | 8.56 | .24 | .42 | 60.23 | .60 | 18.83 | .66 |
| | 8.75 | 91.25 | 3.50 | 9.31 | .25 | .54 | 57.83 | .62 | 19.98 | .79 |
| | 8.97 | 91.03 | 3.40 | 9.44 | .22 | .26 | 57.69 | .58 | 19.91 | .48 |
| | 8.84 | 91.16 | 3.28 | 8.94 | T | .48 | 59.51 | .53 | 18.90 | .48 |
| | 8.22 | 91.78 | 3.37 | 8.69 | T | .44 | 60.04 | .48 | 19.20 | .44 |
| Average | 7.57 | 92.43 | 3.30 | 8.80 | .17 | .30 | 60.29 | .53 | 19.51 | .47 |
| Utah | 7.48 | 92.52 | 5.22 | 11.38 | .44 | .29 | 50.75 | .59 | 24.58 | .73 |
| | 7.09 | 92.91 | 5.67 | 10.19 | .31 | T | 52.47 | .87 | 23.71 | .31 |
| | 7.02 | 92.98 | 4.13 | 10.00 | .43 | .65 | 56.98 | .58 | 21.30 | 1.08 |
| | 6.73 | 93.27 | 4.10 | 8.81 | .32 | .70 | 58.80 | .47 | 21.09 | 1.02 |
| | 6.43 | 93.57 | 6.06 | 12.69 | .49 | .43 | 47.75 | 1.04 | 26.03 | .92 |
| Average | 6.95 | 93.05 | 5.04 | 10.61 | .40 | .41 | 53.35 | .71 | 23.34 | .81 |
| Colorado | 7.26 | 92.74 | 5.88 | 14.56 | .25 | .11 | 45.23 | 1.00 | 26.07 | .36 |
| | 7.22 | 92.78 | 6.04 | 11.06 | .25 | .18 | 52.43 | .62 | 22.63 | .43 |
| | 5.33 | 94.67 | 10.06 | 9.50 | .27 | .28 | 50.72 | .80 | 23.59 | .55 |
| | 8.93 | 91.07 | 6.73 | 10.00 | .43 | .71 | 49.23 | .50 | 24.61 | 1.14 |
| | 9.25 | 90.75 | 7.52 | 11.19 | .25 | .89 | 47.31 | .60 | 24.13 | 1.14 |
| | 7.46 | 92.54 | 3.93 | 9.13 | T | 1.91 | 57.89 | .50 | 21.08 | 1.91 |
| | 7.24 | 92.76 | 4.09 | 9.50 | .47 | .54 | 56.89 | .62 | 21.66 | 1.01 |
| | 7.28 | 92.72 | 4.26 | 9.75 | .22 | 1.14 | 56.68 | .67 | 21.36 | 1.36 |
| Average | 7.50 | 92.50 | 6.06 | 10.59 | .27 | .72 | 52.05 | .66 | 23.14 | .99 |
| Kansas | 6.47 | 93.53 | 3.89 | 10.19 | .12 | .27 | 59.86 | .26 | 19.33 | .39 |
| | 6.27 | 93.73 | 3.84 | 10.31 | .21 | .27 | 60.02 | .29 | 19.26 | .48 |
| | 6.02 | 93.98 | 3.62 | 10.44 | .27 | .26 | 60.31 | .25 | 19.36 | .53 |
| | 8.18 | 91.82 | 3.80 | 9.13 | .20 | 1.23 | 59.74 | .23 | 18.92 | 1.43 |
| | 8.31 | 91.69 | 6.12 | 8.75 | .29 | .73 | 56.80 | .30 | 19.72 | 1.02 |
| | 8.75 | 91.25 | 3.91 | 8.38 | .14 | 1.23 | 58.96 | .22 | 19.79 | 1.37 |
| | 8.55 | 91.45 | 3.05 | 8.69 | .21 | .56 | 60.84 | .44 | 18.43 | .77 |
| | 8.11 | 91.89 | 3.50 | 8.94 | .29 | .48 | 60.64 | .35 | 18.46 | .77 |
| Average | 7.58 | 92.42 | 3.97 | 9.35 | .22 | .63 | 59.65 | .29 | 19.16 | .85 |
| California | 8.52 | 91.48 | 2.57 | 9.25 | .22 | .80 | 61.70 | .50 | 17.45 | 1.02 |
| | 7.38 | 92.62 | 2.98 | 10.00 | T | T | 59.06 | .40 | 20.17 | T |
| | 7.42 | 92.58 | 3.84 | 10.19 | .49 | 5.16 | 58.90 | .44 | 19.20 | 5.65 |
| Average | 7.77 | 92.23 | 3.13 | 9.81 | .24 | -------- | 59.89 | .45 | 18.94 | -------- |
| Average: 32 samples | 7.48 | 92.52 | 4.41 | 9.76 | .25 | [5] .52 | 56.95 | .52 | 20.88 | [5] .77 |
| Maximum | 9.25 | 94.76 | 10.06 | 14.56 | .49 | [5] 1.91 | 63.42 | 1.04 | 26.07 | [5] 1.91 |
| Minimum | 5.24 | 90.75 | 2.57 | 8.06 | T | None. | 45.23 | .22 | 17.45 | T |
| Spread | 4.01 | 4.01 | 7.49 | 6.50 | .49 | 1.91 | 18.19 | .82 | 8.62 | 1.91 |
| QUOTED ANALYSES | | | | | | | | | | |
| Woll and Humphrey [6] | 4.41 | 95.59 | 4.07 | 8.31 | -------- | -------- | -------- | .73 | 19.02 | 5.71 |
| Brock [3] | 7.6 | 92.4 | 3.3 | 9.8 | -------- | -------- | 58.4 | 1.0 | 19.8 | -------- |
| Henry and Morrison [4] | 8.2 | 91.8 | 3.5 | 8.9 | -------- | -------- | 59.6 | .9 | 18.9 | -------- |

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[3] Brock, J. A. Op. cit.

[4] Henry, W. A., and F. B. Morrison. Op. cit.

[5] Omitting 5.16 and 5.65 results.

[6] Woll, F. W., and George C. Humphrey. Dried beet pulp or molasses beet pulp for dairy cows. *In* Wis. Agr. Exp. Sta. 22d Ann. Rpt., p. 108-117. 1905. In addition to the constituents here given the table cited (p. 110) shows 57.75 per cent of "Gums, resin, etc." for the dried pulp, the water-free calculation of which is 60.41 per cent.

TABLE 1.—*Composition of beet pulp*—Continued

| Source | Water-free basis (per cent) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ash (total) | Protein (N×6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| 1 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| Michigan | 3. 33<br>3. 35<br>3. 32<br>3. 73<br>3. 84<br>3. 74<br>3. 60<br>3. 67 | 9. 81<br>8. 51<br>8. 71<br>9. 34<br>10. 20<br>10. 37<br>9. 81<br>9. 47 | 0. 27<br>. 18<br>. 21<br>. 26<br>. 27<br>. 24<br>T<br>T | None.<br>0. 12<br>. 17<br>. 46<br>. 59<br>. 29<br>. 53<br>. 48 | 64. 72<br>66. 93<br>66. 85<br>65. 72<br>63. 38<br>63. 38<br>65. 28<br>65. 42 | 0. 91<br>. 27<br>. 35<br>. 66<br>. 68<br>. 64<br>. 58<br>. 52 | 21. 23<br>20. 94<br>20. 77<br>20. 55<br>21. 90<br>21. 87<br>20. 73<br>20. 92 | 0. 27<br>. 30<br>. 38<br>. 72<br>. 86<br>. 53<br>. 53<br>. 48 |
| Average | 3. 57 | 9. 53 | . 18 | . 33 | 65. 21 | . 58 | 21. 11 | . 51 |
| Utah | 5. 64<br>6. 10<br>4. 44<br>4. 40<br>6. 48 | 12. 30<br>10. 97<br>10. 75<br>9. 45<br>13. 56 | . 47<br>. 33<br>. 46<br>. 34<br>. 52 | . 31<br>T<br>. 70<br>. 75<br>. 46 | 54. 85<br>56. 47<br>61. 28<br>63. 04<br>51. 03 | . 64<br>. 94<br>. 62<br>. 50<br>1. 11 | 26. 57<br>25. 52<br>22. 91<br>22. 61<br>27. 82 | . 78<br>. 33<br>1. 16<br>1. 09<br>. 98 |
| Average | 5. 41 | 11. 41 | . 42 | . 44 | 57. 33 | . 76 | 25. 09 | . 86 |
| Colorado | 6. 34<br>6. 51<br>10. 63<br>7. 39<br>8. 29<br>4. 25<br>4. 41<br>4. 59 | 15. 70<br>11. 92<br>10. 03<br>10. 98<br>12. 33<br>9. 87<br>10. 24<br>10. 52 | . 27<br>. 27<br>. 29<br>. 47<br>. 28<br>T<br>. 51<br>. 24 | . 12<br>. 19<br>. 30<br>. 78<br>. 98<br>2. 06<br>. 58<br>1. 23 | 48. 77<br>56. 51<br>53. 58<br>54. 06<br>52. 13<br>62. 56<br>61. 33<br>61. 13 | 1. 08<br>. 67<br>. 84<br>. 55<br>. 66<br>. 54<br>. 67<br>. 72 | 28. 11<br>24. 39<br>24. 92<br>27. 02<br>26. 59<br>22. 78<br>23. 35<br>23. 04 | . 39<br>. 46<br>. 59<br>1. 25<br>1. 26<br>2. 06<br>1. 09<br>1. 47 |
| Average | 6. 55 | 11. 45 | . 29 | . 78 | 56. 26 | . 72 | 25. 03 | 1. 07 |
| Kansas | 4. 16<br>4. 10<br>3. 85<br>4. 14<br>6. 67<br>4. 28<br>3. 34<br>3. 81 | 10. 89<br>11. 00<br>11. 11<br>9. 94<br>9. 54<br>9. 18<br>9. 50<br>9. 73 | . 13<br>. 22<br>. 30<br>. 22<br>. 32<br>. 15<br>. 23<br>. 32 | . 29<br>. 29<br>. 28<br>1. 34<br>. 80<br>1. 35<br>. 61<br>. 52 | 64. 00<br>64. 04<br>64. 17<br>65. 06<br>61. 95<br>64. 61<br>66. 53<br>65. 99 | . 28<br>. 31<br>. 27<br>. 25<br>. 33<br>. 24<br>. 48<br>. 38 | 20. 67<br>20. 55<br>20. 60<br>20. 61<br>21. 51<br>21. 69<br>20. 15<br>20. 09 | . 42<br>. 51<br>. 58<br>1. 56<br>1. 12<br>1. 50<br>. 84<br>. 84 |
| Average | 4. 29 | 10. 11 | . 24 | . 68 | 64. 54 | . 32 | 20. 73 | . 92 |
| California | 2. 81<br>3. 22<br>4. 15 | 10. 11<br>10. 80<br>11. 01 | . 24<br>T<br>. 53 | . 87<br>T<br>5. 57 | 67. 45<br>63. 77<br>63. 62 | . 55<br>. 43<br>. 48 | 19. 08<br>21. 78<br>20. 74 | 1. 11<br>T<br>6. 10 |
| Average | 3. 39 | 10. 64 | . 26 | ---------- | 64. 95 | . 49 | 20. 53 | ---------- |
| Average: 32 samples | 4. 77 | 10. 55 | . 27 | [7] . 56 | 61. 55 | . 57 | 22. 56 | [7] . 83 |
| Maximum | 10. 63 | 15. 70 | . 53 | [7] 2. 06 | 67. 45 | 1. 11 | 28. 11 | [7] 2. 06 |
| Minimum | 2. 81 | 8. 51 | T | None. | 48. 77 | . 24 | 19. 08 | T |
| Spread | 7. 82 | 7. 19 | . 53 | 2. 06 | 18. 68 | . 87 | 9. 03 | 2. 06 |
| QUOTED ANALYSES | | | | | | | | |
| Shaw [2] | 3. 60 | 11. 50 | ---------- | ---------- | 62. 50 | 1. 30 | 21. 10 | ---------- |
| Woll and Humphrey [6] | 4. 26 | 8. 69 | ---------- | ---------- | ---------- | . 76 | 19. 90 | 5. 97 |
| Brock [3] | 3. 57 | 10. 61 | ---------- | ---------- | 63. 20 | 1. 08 | 21. 43 | ---------- |
| Henry and Morrison [4] | 3. 81 | 9. 69 | ---------- | ---------- | 64. 92 | . 98 | 20. 59 | ---------- |

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[2] Shaw, G. W. Op. cit.
[3] Brock, J. A. Op. cit.
[4] Henry, W.A., and F. B. Morrison. Feeds and feeding. Ed. 18. x, 770 pp., illus. Madison, Wis. 1923.
[6] Woll, F. W., and George C. Humphrey. Dried beet pulp or molasses beet pulp for dairy cows. *In* Wis. Agr. Exp. Sta. 22d Ann. Rpt., p. 108–117. 1905. In addition to the constituents here given the table cited (p. 110) shows 57.75 per cent of "Gums, resin, etc." for the dried pulp, the water-free calculation of which is 60.41 per cent.
[7] Omitting 5.57 and 6.10 results.

Table 2.—*Approximate extremes of variation in the composition of beet pulp, as shown in Table 1*

| Constituents | Wet pulp | Water-free material |
|---|---|---|
| Protein per cent | 0.5 to 1.7 | 8.5 to 15.7 |
| Fat (crude ether extract) do | .02 to .14 | .2 to 1.1 |
| Sugar (apparent) do | Trace to .13 | Trace to 2.1 |
| Nitrogen-free extract do | 1.8 to 11.9 | 48.8 to 67.5 |
| Crude fiber do | 1.0 to 3.8 | 19.1 to 28.1 |
| Crude ash (ash and dirt) do | .2 to .7 | 2.8 to 10.6 |

Table 3.—*Composition of silage from beet pulp*

| Source | Constituents (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N × 6.25) | Reducing substances (direct as invert sugar)[1] | Apparent sucrose (reducing sugar method)[1] | Nitrogen-free-extract (includes the sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert)[1] |
| Original material: | | | | | | | | | | |
| Utah | 92.54 | 7.46 | 0.71 | 1.12 | Trace. | Trace. | 3.06 | 0.17 | 2.40 | Trace. |
| | 88.74 | 11.26 | .59 | 1.81 | do | do | 4.24 | .18 | 4.44 | Do. |
| | 90.29 | 9.71 | .35 | 1.44 | do | do | 2.96 | .37 | 4.59 | Do. |
| Colorado | 91.24 | 8.76 | .72 | 1.11 | do | do | 4.46 | .08 | 2.39 | Do. |
| | 89.57 | 10.43 | .66 | 1.41 | do | do | 5.06 | .10 | 3.19 | Do. |
| Average | 90.48 | 9.52 | .61 | 1.38 | do | do | 3.95 | .18 | 3.40 | Do. |
| Maximum | 92.54 | 11.26 | .72 | 1.81 | do | do | 5.06 | .37 | 4.59 | Do. |
| Minimum | 88.74 | 7.46 | .35 | 1.11 | do | do | 2.96 | .08 | 2.39 | Do. |
| Spread | 3.80 | 3.80 | .37 | .70 | do | do | 2.10 | .29 | 2.20 | Do. |
| Water-free basis: | | | | | | | | | | |
| Utah | | | 9.57 | 15.02 | do | do | 41.05 | 2.25 | 32.11 | Do. |
| | | | 5.22 | 16.11 | do | do | 37.64 | 1.61 | 39.42 | Do. |
| | | | 3.65 | 14.85 | do | do | 30.42 | 3.77 | 47.31 | Do. |
| Colorado | | | 8.17 | 12.72 | do | do | 50.93 | .91 | 27.27 | Do. |
| | | | 6.31 | 13.56 | do | do | 48.47 | 1.04 | 30.62 | Do. |
| Average | | | 6.58 | 14.45 | do | do | 41.70 | 1.92 | 35.35 | Do. |
| Maximum | | | 9.57 | 16.11 | do | do | 50.93 | 3.77 | 47.31 | Do. |
| Minimum | | | 3.65 | 12.72 | do | do | 30.42 | .91 | 27.27 | Do. |
| Spread | | | 5.92 | 3.39 | do | do | 20.51 | 2.86 | 20.04 | Do. |
| QUOTED ANALYSES | | | | | | | | | | |
| Original material: | | | | | | | | | | |
| True[2] | 88.90 | 11.10 | 0.40 | 1.50 | | | 5.40 | 0.20 | 3.60 | |
| Henry and Morrison[3] | 90.00 | 10.00 | .30 | 1.50 | | | 4.70 | .40 | 3.10 | |
| Shaw[4] | 88.87 | 11.13 | .45 | 1.50 | | | 5.42 | .21 | 3.55 | |
| Water-free basis: | | | | | | | | | | |
| True[2] | | | 3.60 | 13.51 | | | 48.65 | 1.80 | 32.43 | |
| Henry and Morrison[3] | | | 3.00 | 15.00 | | | 47.00 | 4.00 | 31.00 | |
| Shaw[4] | | | 4.04 | 13.48 | | | 48.69 | 1.89 | 31.90 | |

[1] It is hardly possible that sugars were present, and it is considered that the very slight reducing action was due to some compound such as, possibly, acetylmethylcarbinol noted in vinegar by Balcom (Balcom, R. W. The volatile reducing substance in cider vinegar. *In* Jour. Amer. Chem. Soc., v. 39, p. 309–315, 1917); and "ereptone," the protein decomposition product noted by Last (Last, Erwin. Uber die quantitative Bestimmung von geringen Zuckermengen bei Gegenwart von höheren und niederen Eiweissabbauprodukten. *In* Biochem. Ztschr., Bd. 93, p. 66–81, 1919).

[2] True, A. C. Experiment station work, XXI. U. S. Dept. Agr., Farmers' Bul. 162, 32 p., 3 fig. 1903.

[3] Henry, W. A., and F. B. Morrison. Op. cit.

[4] Shaw, G. W. Op. cit.

TABLE 4.—*Approximate extremes of variation in the composition of silage from beet pulp, as shown in Table 3*

| Constituents | | Wet silage | Water-free material |
|---|---|---|---|
| Protein | per cent | 1.1 to 1.8 | 12.7 to 16.1 |
| Fat (crude ether extract) | do | .1 to .4 | .9 to 3.8 |
| Sugar (apparent) | do | Trace. | Trace. |
| Nitrogen-free extract | do | 3.0 to 5.1 | 30.4 to 50.9 |
| Crude fiber | do | 2.4 to 4.6 | 27.3 to 47.3 |
| Crude ash (ash and dirt) | do | .4 to .7 | 3.7 to 9.6 |

Table 5 presents the results of the analyses of beet tops.

The variation in the case of beet-top material is due not only to natural variations of plant growth but is strongly influenced by the presence of dirt, as shown in the results on a water-free basis. The ash content (water-free basis) of clean beet tops varies from about 12 to about 15 per cent, but it will be noted that 14 of the 28 samples had a crude-ash content (ash plus dirt) of more than 25 per cent. The extremes of variation are shown in Table 6.

TABLE 5.—*Composition of beet tops*

| Source | Constituents (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N × 6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes the sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| Original material: | | | | | | | | | | |
| Michigan | 81.64 | 18.36 | 3.11 | 4.39 | 1.70 | 2.14 | 9.02 | 0.19 | 1.65 | 3.84 |
| | 73.82 | 26.18 | 6.96 | 4.97 | .60 | 3.05 | 11.24 | .26 | 2.75 | 3.65 |
| | 86.77 | 13.23 | 2.89 | 2.95 | .68 | 1.24 | 5.96 | .19 | 1.24 | 1.92 |
| | 78.23 | 21.77 | 6.26 | 3.35 | .64 | 1.66 | 9.80 | .24 | 2.12 | 2.30 |
| | 78.22 | 21.78 | 4.68 | 3.82 | .84 | 3.10 | 10.66 | .22 | 2.40 | 3.94 |
| | 79.39 | 20.61 | 4.58 | 3.49 | .73 | 2.28 | 9.76 | .22 | 2.56 | 3.01 |
| Average | 79.68 | 20.32 | 4.75 | 3.83 | .87 | 2.25 | 9.40 | .22 | 2.12 | 3.12 |
| Colorado | 63.63 | 36.37 | 8.24 | 8.54 | 1.11 | .57 | 14.40 | .68 | 4.50 | 1.68 |
| | 64.84 | 35.16 | 9.94 | 5.56 | .89 | 3.68 | 15.44 | .33 | 3.89 | 4.57 |
| | 59.72 | 40.28 | 10.90 | 5.84 | .98 | 4.15 | 17.78 | .35 | 5.41 | 5.13 |
| | 69.36 | 30.64 | 9.98 | 3.73 | 1.12 | 3.25 | 13.12 | .18 | 3.63 | 4.37 |
| | 67.21 | 32.79 | 10.03 | 4.15 | .99 | 3.74 | 14.85 | .24 | 3.52 | 4.73 |
| | 79.52 | 20.48 | 4.46 | 2.86 | .45 | .66 | 9.89 | .15 | 3.12 | 1.11 |
| | 81.20 | 18.80 | 6.00 | 2.53 | .56 | 1.92 | 8.13 | .17 | 1.97 | 2.48 |
| Average | 69.35 | 30.65 | 8.51 | 4.74 | .87 | 2.57 | 13.38 | .30 | 3.72 | 3.44 |
| Kansas | 70.53 | 29.47 | 8.35 | 3.85 | 1.30 | 4.96 | 14.37 | .29 | 2.61 | 6.26 |
| | 73.36 | 26.64 | 7.16 | 3.43 | 1.03 | 4.87 | 13.35 | .20 | 2.50 | 5.90 |
| | 68.11 | 31.89 | 10.05 | 3.98 | 1.07 | 4.49 | 15.10 | .36 | 2.40 | 5.56 |
| | 69.82 | 30.18 | 5.35 | 4.84 | 1.32 | 6.68 | 16.55 | .23 | 3.21 | 8.00 |
| | 76.86 | 23.14 | 5.53 | 3.25 | .45 | 4.11 | 11.71 | .19 | 2.46 | 4.56 |
| Average | 71.74 | 28.26 | 7.29 | 3.87 | 1.03 | 5.02 | 14.21 | .25 | 2.64 | 6.05 |
| California | 79.03 | 20.97 | 4.54 | 4.04 | .36 | 3.50 | 9.87 | .27 | 2.25 | 3.86 |
| | 85.45 | 14.55 | 3.07 | 2.70 | .54 | 1.58 | 6.80 | .25 | 1.73 | 2.12 |
| | 78.82 | 21.18 | 4.49 | 3.45 | .35 | 3.85 | 10.66 | .33 | 2.25 | 4.20 |
| | 80.17 | 19.83 | 3.28 | 3.03 | .86 | 4.58 | 11.36 | .24 | 1.92 | 5.44 |
| Average | 80.87 | 19.13 | 3.85 | 3.31 | .53 | 3.38 | 9.66 | .27 | 2.04 | 3.91 |
| Average, 22 samples | 74.80 | 25.20 | 6.36 | 4.03 | .84 | 3.18 | 11.81 | .26 | 2.73 | 4.02 |
| Maximum | 86.77 | 40.28 | 10.90 | 8.54 | 1.70 | 6.68 | 17.78 | .68 | 5.41 | 8.00 |
| Minimum | 59.72 | 13.23 | 2.89 | 2.53 | .35 | .57 | 5.96 | .15 | 1.24 | 1.11 |
| Spread | 27.05 | 27.05 | 8.01 | 6.01 | 1.35 | 6.11 | 11.82 | .53 | 4.17 | 6.89 |

TABLE 5.—*Composition of beet tops*—Continued

| Source | Constituents (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N × 6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes the sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| Water-free basis: | | | | | | | | | | |
| Michigan | -------- | -------- | 16.95 | 23.89 | 9.27 | 11.64 | 49.14 | 1.02 | 9.00 | 20.91 |
| | | | 26.57 | 18.97 | 2.30 | 11.66 | 42.95 | 1.01 | 10.50 | 13.96 |
| | | | 21,88 | 22.32 | 5.15 | 9.40 | 45.02 | 1.43 | 9.35 | 14.55 |
| | | | 28.76 | 15.41 | 2.94 | 7.63 | 44.98 | 1.09 | 9.76 | 10.57 |
| | | | 21.47 | 17.52 | 3.86 | 14.22 | 48.98 | 1.02 | 11.01 | 18.08 |
| | | | 22.23 | 16.91 | 3.52 | 11.07 | 47.34 | 1.08 | 12.44 | 14.59 |
| Average | -------- | -------- | 22.98 | 19.17 | 4.51 | 10.94 | 46.40 | 1.11 | 10.34 | 15.45 |
| Utah | -------- | -------- | 36.04 | 13.53 | 2.77 | 4.12 | 37.95 | 1.43 | 11.05 | 6.89 |
| | | | 26.50 | 12.83 | 4.50 | 9.00 | 48.83 | 1.35 | 10.49 | 13.50 |
| | | | 39.05 | 13.32 | 2.41 | 1.80 | 35.97 | .91 | 10.75 | 4.21 |
| | | | 38.21 | 10.54 | 2.26 | 8.63 | 40.40 | 1.47 | 9.38 | 10.89 |
| | | | 23.30 | 11.28 | 7.67 | 13.76 | 54.60 | 1.78 | 9.04 | 21.43 |
| | | | 24.50 | 12.21 | 6.28 | 13.26 | 51.40 | 1.78 | 10.11 | 19.54 |
| Average | -------- | -------- | 31.27 | 12.29 | 4.32 | 8.43 | 44.86 | 1.45 | 10.14 | 12.75 |
| Colorado | -------- | -------- | 22.65 | 23.49 | 3.05 | 1.57 | 39.60 | 1.88 | 12.38 | 4.62 |
| | | | 28.28 | 15.80 | 2.53 | 10.47 | 43.92 | .93 | 11.07 | 13.00 |
| | | | 27.05 | 14.50 | 2.43 | 10.31 | 44.17 | .86 | 13.42 | 12.74 |
| | | | 32.56 | 12.16 | 3.65 | 10.62 | 42.83 | .60 | 11.85 | 14.27 |
| | | | 30.60 | 12.65 | 3.02 | 11.41 | 45.30 | .73 | 10.72 | 14.43 |
| | | | 21.77 | 13.98 | 2.20 | 3.22 | 48.30 | .72 | 15.23 | 5.42 |
| | | | 31.93 | 13.44 | 2.97 | 10.22 | 43.20 | .93 | 10.50 | 13.19 |
| Average | -------- | -------- | 27.83 | 15.15 | 2.84 | 8.26 | 43.90 | .95 | 12.17 | 11.10 |
| Kansas | -------- | -------- | 28.33 | 13.07 | 4.40 | 16.84 | 48.78 | .97 | 8.85 | 21.24 |
| | | | 26.86 | 12.88 | 3.86 | 18.28 | 50.13 | .76 | 9.37 | 22.14 |
| | | | 31.52 | 12.48 | 3.35 | 14.07 | 47.34 | 1.14 | 7.52 | 17.42 |
| | | | 17.72 | 16.04 | 4.36 | 22.15 | 54.86 | .76 | 10.62 | 26.51 |
| | | | 23.91 | 14.05 | 1.96 | 17.77 | 50.61 | .81 | 10.62 | 19.73 |
| Average | -------- | -------- | 25.67 | 13.70 | 3.59 | 17.82 | 50.34 | .89 | 9.40 | 21.41 |
| California | -------- | -------- | 21.64 | 19.25 | 1.73 | 16.71 | 47.10 | 1.28 | 10.73 | 18.44 |
| | | | 21.12 | 18.55 | 3.71 | 10.86 | 46.70 | 1.73 | 11.90 | 14.57 |
| | | | 21.22 | 16.31 | 1.67 | 18.18 | 50.29 | 1.56 | 10.62 | 19.85 |
| | | | 16.54 | 15.30 | 4.35 | 23.12 | 57.25 | 1.21 | 9.70 | 27.47 |
| Average | -------- | -------- | 20.13 | 17.35 | 2.87 | 17.22 | 50.33 | 1.45 | 10.74 | 20.09 |
| Average, 28 samples | -------- | -------- | 26.04 | 15.45 | 3.65 | 11.86 | 46.71 | 1.15 | 10.64 | 15.51 |
| Maximum | -------- | -------- | 39.05 | 23.89 | 9.27 | 23.12 | 57.25 | 1.88 | 15.23 | 27.47 |
| Minimum | -------- | -------- | 16.54 | 10.54 | 1.67 | 1.57 | 35.97 | .60 | 7.52 | 4.21 |
| Spread | -------- | -------- | 22.51 | 13.35 | 7.60 | 21.55 | 21.28 | 1.28 | 7.71 | 23.26 |
| AVERAGE OF QUOTED ANALYSES | | | | | | | | | | |
| Original material: | | | | | | | | | | |
| Malpeaux[1] | 81.8 | 18.2 | 6.4 | 1.78 | -------- | -------- | -------- | .2 | 1.82 | 8.0 |
| Henry and Morrison[2] | 88.6 | 11.4 | 2.0 | 2.6 | -------- | -------- | -------- | .3 | 1.2 | 5.3 |
| Water-free basis: | | | | | | | | | | |
| Malpeaux[1] | -------- | -------- | 35.16 | 9.78 | -------- | -------- | 43.96 | 1.10 | 10.00 | -------- |
| Henry and Morrison[2] | -------- | -------- | 17.54 | 22.81 | -------- | -------- | 46.49 | 2.63 | 10.53 | -------- |

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[1] Malpeaux, L. Les feuilles et les collets de betteraves dans l'alimentation du bétail. *In* La Vie Agricole, ann. 6, p. 387. 1916.

[2] Henry, W. A., and F. B. Morrison. Op. cit.

TABLE 6.—*Approximate extremes of variation in the composition of beet tops, as shown in Table 5*

| Constituents | | Original wet material | Water-free material |
|---|---|---|---|
| Protein | per cent | 2.5 to 8.5 | 10.5 to 23.9 |
| Fat (crude ether extract) | do | .2 to .7 | .6 to 1.9 |
| Sugar (apparent) | do | 1.1 to 8.0 | 4.2 to 27.5 |
| Nitrogen-free extract | do | 6.0 to 17.8 | 36.0 to 57.3 |
| Crude fiber | do | 1.2 to 5.4 | 7.5 to 15.2 |
| Crude ash (ash and dirt) | do | 2.9 to 10.9 | 16.5 to 39.1 |

The chief characteristic of the results of analyses of beet-top silage (Table 7) is the enormous crude-ash content (ash plus dirt), which on a water-free basis varies from 20.82 to 58.48 per cent, five samples having more than 50 per cent.

The extremes of variation in the constituents are shown in Table 8.

TABLE 7.—*Composition of beet-top silage*

[T=trace.]

| Source | Constituents (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N × 6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes the sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| Original material: | | | | | | | | | | |
| Utah— | | | | | | | | | | |
| Top of silo | 78.70 | 21.30 | 9.02 | 2.17 | 0.32 | None. | 7.38 | 0.30 | 2.43 | 0.32 |
| 6 inches from top of silo | 69.99 | 30.01 | 11.47 | 2.54 | 2.51 | 0.18 | 12.50 | .60 | 2.90 | 2.69 |
| Bottom of silo | 64.18 | 35.82 | 18.31 | 2.44 | 1.29 | None. | 11.42 | .54 | 3.11 | 1.29 |
| 6 inches from top of silo | 65.42 | 34.58 | 15.05 | 4.13 | .34 | .05 | 11.05 | .39 | 3.96 | .39 |
| 30 inches from top of silo | 52.53 | 47.47 | 20.53 | 5.50 | 1.59 | .25 | 14.73 | .68 | 6.03 | 1.84 |
| Representative | 71.62 | 28.38 | 16.60 | 1.57 | .12 | None. | 7.32 | .38 | 2.51 | .12 |
| Do | 62.88 | 37.12 | 16.40 | 4.19 | .40 | None. | 12.33 | .89 | 3.31 | .40 |
| Do. (spoiled) | 65.18 | 34.82 | 17.65 | 3.97 | .40 | None. | 9.11 | .75 | 3.34 | .40 |
| Do | 77.76 | 22.24 | 11.33 | 2.26 | .18 | None. | 5.86 | .56 | 2.24 | .18 |
| Do | 78.67 | 21.33 | 8.05 | 2.50 | .13 | .10 | 7.94 | .24 | 2.60 | .23 |
| Average | 68.69 | 31.31 | 14.44 | 3.13 | .73 | .06 | 9.96 | .53 | 3.24 | .79 |
| Colorado— | | | | | | | | | | |
| Top of silo | 73.96 | 26.04 | 9.49 | 3.30 | .16 | .04 | 9.32 | .29 | 3.64 | .20 |
| Center of silo | 63.23 | 36.77 | 10.77 | 5.79 | 2.96 | .05 | 15.11 | .51 | 4.59 | 3.01 |
| Bottom of silo | 67.95 | 32.05 | 14.13 | 3.87 | T | T | 9.85 | .48 | 3.71 | T |
| Top of silo | 58.20 | 41.80 | 19.57 | 4.59 | .90 | T | 13.05 | .31 | 4.26 | .90 |
| Center of silo | 73.10 | 26.90 | 12.25 | 2.86 | .18 | None. | 8.23 | .22 | 3.35 | .18 |
| Bottom of silo | 62.38 | 37.62 | 20.86 | 3.08 | .17 | None. | 9.22 | .27 | 4.19 | .17 |
| Representative | 65.95 | 34.05 | 9.55 | 4.54 | .92 | .99 | 15.13 | .24 | 4.60 | 1.91 |
| Do | 51.03 | 48.97 | 10.20 | 7.79 | 1.58 | 2.67 | 23.56 | .24 | 7.19 | 4.25 |
| Average | 64.48 | 35.52 | 13.35 | 4.48 | .86 | .47 | 12.93 | .32 | 4.44 | 1.33 |
| Average, 18 samples | 66.82 | 33.18 | 13.96 | 3.73 | .79 | .24 | 11.28 | .44 | 3.78 | 1.03 |
| Maximum | 78.70 | 48.97 | 20.86 | 7.79 | 2.96 | 2.67 | 23.56 | .89 | 7.19 | 4.25 |
| Minimum | 51.03 | 21.30 | 8.05 | 1.57 | T | None. | 5.86 | .22 | 2.24 | T |
| Spread | 27.67 | 27.67 | 12.81 | 6.22 | 2.96 | 2.67 | 17.70 | .67 | 4.95 | 4.25 |
| Water-free basis: | | | | | | | | | | |
| Utah— | | | | | | | | | | |
| Top of silo | ------ | ------ | 42.37 | 10.17 | 1.48 | None. | 34.63 | 1.40 | 11.43 | 1.48 |
| 6 inches from top of silo | ------ | ------ | 38.21 | 8.47 | 8.36 | .60 | 41.65 | 1.99 | 9.68 | 8.96 |
| Bottom of silo | ------ | ------ | 51.13 | 6.82 | 3.60 | None. | 31.88 | 1.50 | 8.67 | 3.60 |
| 6 inches from top of silo | ------ | ------ | 43.53 | 11.93 | .97 | .16 | 31.95 | 1.13 | 11.46 | 1.13 |
| 30 inches from top of silo | ------ | ------ | 43.25 | 11.59 | 3.36 | .53 | 31.02 | 1.43 | 12.71 | 3.89 |

TABLE 7.—*Composition of beet-top silage*—Continued

| Source | Constituents (per cent) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Solids | Ash (total) | Protein (N × 6.25) | Reducing substances (direct as invert sugar) | Apparent sucrose (reducing sugar method) | Nitrogen-free extract (includes the sugars) | Fat (crude ether extract) | Crude fiber | Total apparent sugars (sucrose plus invert) |
| Water-free basis—Contd. | | | | | | | | | | |
| Utah—Continued. | | | | | | | | | | |
| Representative | ------- | ------- | 58.48 | 5.52 | 0.44 | None. | 25.81 | 1.35 | 8.84 | 0.44 |
| Do | ------- | ------- | 44.18 | 11.28 | 1.07 | None. | 33.22 | 2.41 | 8.91 | 1.07 |
| Do. (spoiled) | ------- | ------- | 50.68 | 11.41 | 1.16 | None. | 26.16 | 2.16 | 9.59 | 1.16 |
| Do | ------- | ------- | 50.93 | 10.16 | .79 | None. | 26.33 | 2.50 | 10.08 | .79 |
| Do | ------- | ------- | 37.74 | 11.73 | .61 | .47 | 37.23 | 1.12 | 12.18 | 1.08 |
| Average | ------- | ------- | 46.05 | 9.91 | 2.18 | .18 | 31.99 | 1.70 | 10.36 | 2.36 |
| Colorado— | | | | | | | | | | |
| Top of silo | ------- | ------- | 36.43 | 12.67 | .63 | .16 | 35.79 | 1.13 | 13.98 | .79 |
| Center of silo | ------- | ------- | 29.28 | 15.75 | 8.04 | .13 | 41.09 | 1.39 | 12.49 | 8.17 |
| Bottom of silo | ------- | ------- | 44.09 | 12.08 | T | T | 30.73 | 1.51 | 11.59 | T |
| Top of silo | ------- | ------- | 46.83 | 10.99 | 2.16 | T | 31.23 | .75 | 10.20 | 2.16 |
| Center of silo | ------- | ------- | 45.54 | 10.63 | .67 | None. | 30.59 | .80 | 12.44 | .67 |
| Bottom of silo | ------- | ------- | 55.46 | 8.18 | .46 | None. | 24.50 | .71 | 11.15 | .46 |
| Representative | ------- | ------- | 28.04 | 13.33 | 2.71 | 2.90 | 44.43 | .70 | 13.50 | 5.61 |
| Do | ------- | ------- | 20.82 | 15.90 | 3.23 | 5.45 | 48.11 | .48 | 14.69 | 8.68 |
| Average | ------- | ------- | 38.31 | 12.44 | 2.24 | 1.08 | 35.81 | .93 | 12.51 | 3.32 |
| Average, 18 samples | ------- | ------- | 42.61 | 11.03 | 2.21 | .58 | 33.69 | 1.36 | 11.31 | 2.79 |
| Maximum | ------- | ------- | 58.48 | 15.90 | 8.36 | 5.45 | 48.11 | 2.50 | 14.69 | 8.96 |
| Minimum | ------- | ------- | 20.82 | 5.52 | T | None. | 24.50 | .48 | 8.67 | T |
| Spread | ------- | ------- | 37.66 | 10.38 | 8.36 | 5.45 | 23.61 | 2.02 | 6.02 | 8.96 |
| AVERAGE OF QUOTED ANALYSES | | | | | | | | | | |
| Original material: | | | | | | | | | | |
| Malpeaux[1] | 89.80 | 10.20 | 4.98 | 1.01 | ------- | ------- | 3.08 | .10 | 1.03 | ------- |
| Jones[2] | 64.36 | 35.64 | 9.25 | 2.87 | ------- | ------- | 17.62 | .44 | 5.46 | ------- |
| Neidig[3] | 70.70 | 29.30 | 13.28 | 3.27 | ------- | ------- | 9.73 | .65 | 2.36 | ------- |
| Water-free basis: | | | | | | | | | | |
| Malpeaux[1] | ------- | ------- | 48.82 | 9.90 | ------- | ------- | 30.20 | .98 | 10.10 | ------- |
| Jones[2] | ------- | ------- | 25.95 | 8.05 | ------- | ------- | 49.44 | 1.23 | 15.32 | ------- |
| Neidig[3] | ------- | ------- | 45.18 | 10.90 | ------- | ------- | 33.59 | 2.26 | 8.07 | ------- |

[1] Malpeaux, L. Op. cit. [2] Jones, James W. Op. cit. [3] Neidig, R. E. Op. cit.

TABLE 8.—*Approximate extremes of variation in the composition of beet-top silage, as shown in Table 7*

| Constituents | Original wet material | Water-free material |
|---|---|---|
| Protein ........ per cent | 1.6 to 7.8 | 5.5 to 15.9 |
| Fat (crude ether extract) ........ do | .2 to .9 | .5 to 2.5 |
| Sugar (apparent) ........ do | Trace to 4.3 | Trace to 9.0 |
| Nitrogen-free extract ........ do | 5.9 to 23.6 | 24.5 to 48.1 |
| Crude fiber ........ do | 2.2 to 7.2 | 8.7 to 14.7 |
| Crude ash (ash and dirt) ........ do | 8.1 to 20.9 | 20.8 to 58.5 |

The average of the five samples carrying more than 50 per cent ash (by percentages), computed on a water-free basis, is ash, 53.34; protein, 8.42; nitrogen-free extract, 26.94; fat, 1.64; fiber, 9.67.

If the excess dirt had been removed from this material, leaving only the normal ash content of clean beet tops—approximately 15 per cent on the basis of water-free material—the composition of the material (by percentages) would have been ash, 15; protein, 15.34; nitrogen-free extract, 49.06; fat, 2.98; fiber, 17.62.

Carelessness in permitting this quantity of dirt to remain on the beet tops results in the feeding value being reduced to nearly half that of clean tops. Assuming a daily ration of 35 pounds of wet silage of this character, the cattle would be given only about half the feed that they would receive if fed clean, dirt-free material, and in addition they would consume dirt averaging 4.3 pounds in weight and varying from 2.3 to 5.6 pounds. Cases have been reported of the death of animals fed largely on beet-top silage, and no doubt some of the deaths were due to the excessive quantity of dirt present. Even if it did not result in death, the consumption of such large quantities of dirt would undoubtedly cause serious digestive troubles. The greatest care should be taken to avoid and to eliminate dirt in the harvesting, siloing, and feeding of beet tops.

Examination of the average figures on the water-free basis in Tables 5 and 7 shows a marked decrease in the protein and nitrogen-free extract in the beet-top silage, as compared with the quantities in the fresh tops. No doubt a considerable part of this apparent loss is due to the relatively very much greater ash content of the silage, but fermentation during the process of conversion into silage is responsible for part of it and is undoubtedly responsible for a loss of actual sugar amounting to about 12 per cent. This lost food material could be conserved by shredding and drying the tops; but its loss is offset by the fact that the silage affords a succulent, slightly acid feed during the winter months that is greatly relished by stock and apparently exerts a beneficial effect upon their digestive processes. The use of the tops in the form of silage is favored further by the consideration that it may be prepared by the individual farmer at very small expense.

Nearly all the samples of silage were in a dried condition when received, and no investigation of the acids present was made. The characteristic odor that is usually noticeable in beet-top silage indicates the presence of butyric acid. It has been concluded that its presence in corn silage indicates abnormal fermentation. In the case of beet-top silage it is possible that its presence is characteristic, though it is more probable that it is due to abnormal fermentation resulting from the imperfect packing of the material in the silo and the presence of excessive amounts of air. Its presence does not lessen the relish with which the silage is eaten by stock, and apparently it is not harmful.

## SUMMARY

Analyses of a considerable number of samples of beet pulp, beet tops, and silage therefrom are given in detail.

The excessive quantity of dirt found in beet tops and beet-top silage is pointed out, and farmers are cautioned as to the effect of this dirt upon stock to which it is fed.

## ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

July 9, 1924.

| | |
|---|---|
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